EverGreen
The Newsletter of the
Kerala Forest Research Institute
(An Institution of Kerala State Council for Science, Technology and Environment)
ISSN 0254-6426

Evergreen, the newsletter of the Kerala Forest Research Institute, brought out in March and September, is intended for free distribution to individuals and institutions connected with forestry. The views expressed in the newsletter are those of authors and do not necessarily reflect the views of the Institute. The readers are welcome to communicate their comments and opinions. The Newsletter Committee reserves the right to choose among the contributions and make necessary editorial modifications.

Cover content contribution:
Mr. Sandeep Das
Dr. P Sujanapal

Address all communications to:

The Editor, Evergreen
Kerala Forest Research Institute
Peechi-680 653
Thrissur, Kerala, India
Phone: +91 487 2690100
E-mail: evergreen@kfri.res.in
evergreenkfri@gmail.com


Chembra Peak

Newsletter of Kerala Forest Research Institute
Evergreen
April 2013-September 2013 Vol:71

'Shola Forests'

The late cretaceous activities on land mass have moulded a mega-relief, the Western Ghats. This relief, with its ascends and descends have provided many kaleidoscopic biological niches in its crest above 1500 m MSL and formed the most scenic, *Sholas*- the Tropical Montane Forests sandwiched between the rolling grasslands, mainly in the high ranges of Anamalai, Nilgiri and Palani phytogeographical regions. The term '*Shola*' connected to a Tamil word '*Cholai*', which is glorified in the ancient Tamil literature and culture. The Sholas are often referred to as 'living fossils' and is one of the most fragile and threatened ecosystems in the tropics. Blended with incomparable natural beauty, exceptional physiography, unique climatic regimes varying from the ideal tropical type, rich diversity of Rare, Endemic and Threatened species, the Sholas stands unique among the other habitats of the Western Ghats. The trees are stunted, non-stratified, profusely branched with an umbrella shaped canopy. The crooked branches are densely covered with epiphytic mosses, ferns, lichens and orchids. In total, the area under shola-grassland vegetation in Kerala is estimated to be approximately 70 km2. Though, a few large patches are declared as National Parks, almost all the Sholas face severe threat from various anthropogenic activities.


Ficedula nigrorufa
Black and orange flycatcher.


Medinilla malabarica Bedd.


Rhododendron arboreum J. E. Smith *ssp. nilagiricum* (Zenk.) Tagg.

Eravikulam National Park

Evergreen (71) 2-5, 2013
ISSN : 0254-6426

Quantification of Human Disturbance in Natural Forest Stands: A Simple Method to Forest Managers

UM Chandrashekara

Nilambur Subcentre, Kerala Forest Research Institute, Nilambur - 679342
Corresponding author : umchandra@rediffmail.com

Introduction

Throughout the world, natural forests are beleaguered by an array of threats driven by different scales of anthropogenic perturbations. This is particularly true in forest patches that are located adjacent to human habitation. Human population pressure, accentuated by the livestock population, is found to be destructive to ecological patterns and processes of such forests stands. In addition, very often changing pattern of adjacent land-use systems can also exert pressure on forests and associated biodiversity. It is easy to tell a disturbed forest when it has been turned into a grassland or a barren land. However, several traditional forms of forest management are based on the extraction of small amounts of resources at a time, and therefore they are not expected to inflict sudden and complete changes in the environment. This chronic form of disturbance has been acknowledged as the most widespread form of forest destruction in developing countries, where it may be as destructive as other faster-acting forms of disturbance since its effects may be non-linear and cumulative (Gunderson, 2000). For example, in India, though the commercial exploitation of resources from natural forests has been brought to an end as early as in 1980s, incidences of un-authorized collection of minor forest products, particularly from the village-adjacent natural forests, are not uncommon. Available literature indicates that such un-authorized exploitations are also unscientific and contributing to forest degradation and alteration in the species composition. Moreover, a given forest patch may experience disturbance of different forms, magnitude and frequency. For instance, even in certain protected areas within the Nilgiri Biosphere Reserve, disturbances due to biomass collection (small poles, fuel-wood, litter, green mulch materials etc.) and grazing are reported (CES, 1990; Chandrashekara, 2011). Such chronic disturbances create a gradient between pristine and heavily degraded sites, and therefore it needs to be measured on a continuous, rather than dichotomic (undisturbed and disturbed), scale. However, the current challenge is to quantify the level of disturbances to enable the stakeholders and managers of forests to plan rationally on appropriate measures of conservation and management. In general, assessment of the amount of disturbance experienced by a given area is carried out by adopting expert-based methods. These methods rely on the capability of the trained eye to measure the quantum of disturbances caused by different anthropogenic activities. These methods, frequently render binary (disturbed vs. undisturbed) or ordinal scales and are generally qualitative. The other approach of assessment of the level of disturbance is based on biotic indicators. The biotic indicators measure disturbance through its effects on one species, a taxonomic group or on one attribute of the community. There are two main drawbacks in the biotic methods. First, the different intensities, scales, and kinds of disturbances are likely to have different effects on ecosystems, thus the choice of certain biological indicators may set aside the forms of disturbances that have a substantial impact on other components of the community. Considering the limitations of expert-based and biotic indicators method, here a

human activity indicator method (Mutangah, 1996) is explained with data collected on human induced disturbances in ten forest patches, all situated in the Kerala part of Nilgiri Biosphere Reserve.

Data collection and processing

The area under Kerala part of Nilgiri Biosphere Reserve (latitudes 10°50′ and 12°16′N and longitudes 76° and 77°15′E), has been divided into five parts at an interval of 12′ latitude. In each latitude range two forest patches each with a clear forest demarcation boundary and located adjacent to a village and/ or a tribal settlement were selected. Thus ten forest patches selected include those located in Adackakundu (AK), Appencappu (AP), Kadasseri (KA), Manikunnumala (MN), Manaliampadam (MP), Munnadi (MU), Pattakarimba (PK), Parackal (PR), Punchavayal (PU) and Vellimuttam (VL). In each forest patch, adjacent to human habitation, using a GPS, one plot of 0.25 km^2 (500 m x 500 m) was laid. A reconnaissance survey made in each plot helped to notice the presence of one or more type of human disturbance such as larger stumps of harvested trees (>20 cm gbh), pollarded stumps (<20 cm gbh), pruned trees, debarked trees, foot paths and vehicle tracks. Subsequently, for the above mentioned visible indicators (variables) of human disturbance data such a) number of larger stumps of harvested trees (>20 cm gbh), b) number of pollarded stumps (<20 cm gbh), c) number of coppiced stumps, d) number of branch cuttings, e) number of stem debarked, f) number of vehicle tracks, and g) number of foot paths were collected from each plot. The formulae given by Mutangah (1996) were used to calculate the Index of Human Disturbance (IHD).

Individual variable index value,

$$Y = C/C\,max \quad \text{--------- (1)}$$

where, C is variable value in a given plot, C max is the maximum variable value recorded

Index of Human Disturbance Value

$$(IHD) = (\sum Y)/ N) \times 100 \quad \text{--------- (2)}$$

where, N= number of variables studied.

All the seven visible human disturbance variables were seen in all the ten forest plots with an exception being the absence of debarking of stems in three plots namely, KA, PK and VL (Table 1). The number of vehicle tracks, stumps of harvested trees, pollarded trees and tree with branches cut and debarked stems are comparatively more in PU. On the other hand, while the number of coppiced stems is more in MU, foot paths are more in PK.

Managers cannot rely on the values obtained for one or a few disturbance variables. Thus an indicator value obtained based on the measurement of maximum number of variables can be a powerful tool to screen a large number of forest plots to identify plots that

Table 1. Absolute values obtained for disturbance variable for ten forest plots (each of 0.25 km^2) in the Kerala part of Nilgiri Biosphere Reserve.

Disturbance variables	Forest plots									
	AK	AP	KA	MN	MP	MU	PK	PR	PU	VL
Number of larger stumps (> 20 cm gbh) of harvested trees	60	25	16	53	67	55	51	71	76	40
Number of pollarded trees (< 20 cm gbh)	244	61	35	318	263	308	321	263	321	71
Number of coppiced stems	79	22	15	122	85	139	46	78	72	19
Number of stems with branch cuttings	41	38	35	62	54	65	58	52	66	34
Number of debarked stems	66	5	0	65	69	114	0	53	123	0
Number of vehicle tracks	3	1	1	1	4	2	3	2	5	2
Number of foot paths	11	3	2	9	10	9	12	11	9	10

Table 2. Index of Human Disturbance (IHD) values for ten forest plots (each of 0.25 km^2) in the Kerala part of Nilgiri Biosphere Reserve

Disturbance variables	Forest Plots									
	AK	AP	KA	MN	MP	MU	PK	PR	PU	VL
	Individual variable index value (C/C Max)									
Number of larger stumps (> 20 cm gbh) of harvested trees	0.78	0.33	0.21	0.70	0.88	0.72	0.67	0.93	1.00	0.53
Number of pollarded trees (< 20 cm gbh)	0.76	0.19	0.11	0.99	0.82	0.96	1.00	0.82	1.00	0.22
Number of coppiced stems	0.57	0.16	0.11	0.88	0.61	1.00	0.33	0.56	0.52	0.14
Number of stems with branch cuttings	0.62	0.57	0.53	0.94	0.81	0.98	0.87	0.78	1.00	0.51
Number of debarked stems	0.54	0.04	0.00	0.53	0.56	0.93	0.00	0.43	1.00	0.00
Number of vehicle tracks	0.60	0.20	0.20	0.20	0.80	0.40	0.60	0.40	1.00	0.40
Number of foot paths	0.88	0.23	0.18	0.72	0.82	0.77	1.00	0.88	0.78	0.83
Sum of Individual variable index values	4.76	1.73	1.35	4.96	5.30	5.76	4.48	4.81	6.31	2.64
Sum of Individual variable index values/ total number of variables	0.68	0.25	0.19	0.71	0.76	0.82	0.64	0.69	0.90	0.38
Index of Human Disturbance Value (IHD) in %	68.0	24.7	19.2	70.9	75.7	82.3	64.0	68.7	90.1	37.7

are in relatively undisturbed condition or conversely, plots that are exposed to excessive anthropogenic disturbance. In this context, the Index of Human Disturbance (IHD) values calculated for ten plots (Table 2) are relevant. Among ten plots those at Punchavayal (PU) followed by Munnadi (MU) showed high value for the IHD. These high values are the resultants of constant and high magnitude disturbance regimes in these two plots. Impacts of such a high level human disturbance was also reflected in these plots in the form of high contribution by the light demanding species to the density and basal area of seedling, sapling and mature phases of tree community (Chandrashekara, 2011). Overall disturbance in plots like KA and AP is comparatively less as reflected by their lower value for HDI (KA= 19.2% and AP= 24.7%). It may also be mentioned here that in these plots contribution by moderately light demanding (late secondary) and shade tolerant (primary) species to the parameters like density and basal area of tree seedling phase is generally high. These two aspects suggest that the plots are in progressive succession due to reduction in human disturbance in recent years. Thus, further intensification of forest protection activities to reduce illegal collection of small poles and green manure materials can help the forest plots at KA and AP to recover from the past disturbance.

Conclusions

The IHD values obtained for the ten forests plots indicate that they show a gradient of human disturbance. In fact, all these plots are located in the NBR and experiencing precarious status of vegetation due to unsustainable harvest and management practices. Therefore, it is clear that we need to go a long way, as far as the NBR is concerned, to reach the objectives of establishment of a Biosphere Reserve i.e. maintenance of biodiversity and ecological integrity. In this context,

for effective management of forest stands of the Reserve certain early warning tools that detect changes in conditions of forest patches before it is too late to intervene are required. In this context, the IHD is a more appropriate method as it is derived from the quantitative data collected with low levels of effort, time and cost and they are unambiguous and readily repeatable. Since the data can be acquired, if necessary by people without prior scientific education, cheaply and easily, the forest managers, policy-makers, and the public can find this method as a useful screening tool for *a priori* ranking of forest patches at landscape/ regional/ national scale. However, for more rigorous assessment of the level of disturbances in forests, ecological indices are also available (Chandrashekara, 2011).

References

CES (Centre for Ecological Sciences) 1990 Nilgiri Biosphere Reserve: An Overview. Centre for Ecological Sciences, Bangalore.

Chandrashekara UM 2011 Forests and agricultural ecosystem analysis to assess ecosystem health and identify rehabilitation strategies in the Kerala part of Nilgiri Biosphere Reserve. KFRI Research Report 394. Kerala Forest Research Institute, Peechi, Kerala.

Gunderson LH 2000 Ecological resilence- in theory and application. Annual Review of Ecology and Systematics, 31:425-439.

Mutangah JG 1996 An Investigation of Vegetation Status and Process in Relation to Human Disturbance in Kakamaga Forest, Western Kenya. Ph.D. Thesis, University of Wales, UK.

Bamboo Technical Support Group –South (BTSG-South)

The Bamboo Technical Support Group –South Zone which is hosted by KFRI is one of three such groups set up in the country to support the National Bamboo Mission (Ministry of Agriculture and Co-operation) in its mission of bringing integrated development of the bamboo sector. The BTSG- South Zone caters to the requirements of the six states in the South of India viz., Kerala, Karnataka, Tamil nadu, Andhra Pradesh, Goa and Maharashtra. The most popular of BTSG – South activities has been the various training programmes that were organized in the past few years. Field functionaries and farmers involved in cultivation and utilization of bamboo have been imparted training that covers different aspects of the diversity of bamboo species, their biology, diverse range of uses it is put to, the methods of propagation, establishment and management of plantations, harvesting and utilization. The faculty is drawn mostly from the scientists from various disciplines of KFRI which has been in the forefront of research in bamboo for the past three decades. Currently, KFRI is actively engaged in developing manuals and procedures for production and certification of high quality bamboo planting material through High-tech Nurseries. This, when complete, will help NBM ensure that all future plantations of bamboo across the country will be derived from the best of planting material that will enhance the productivity.

For details contact : Dr. R.C. Pandalai,
Co-ordinator, BTSG- South, KFRI, Peechi.
Phone : 0487 2690100 Email: btsg@kfri.res.in

Evergreen (71) 6-8, 2013
ISSN : 0254-6426

A Peep into the Genetic Diversity of Trees in the Western Ghats

Suma Arun Dev[1], PM Sreekanth[2], Renee M Borges[3] and M Balasundaran[4]

[1] Department of Biotechnology, Kerala Forest Research Institute, Peechi,Thrissur - 680653
[2] Biotechnology & Applied Genetics, Bangalore City College, Bangalore - 560043
[3] Centre for Ecological Sciences,Indian Institute of Science, Bangalore - 560012
[4] Tropical Institute of Ecological Sciences, Velloor P.O, Kottayam - 686501
Corresponding author : sumadev@kfri.res.in

Western Ghats, one of the biodiversity hotspots of the world, has over 5000 species of flowering plants with more than 350 endemic tree species. Forest genetic resources in the Western Ghats are facing several threats due to habitat destruction, illegal logging, fragmentation, limited dispersal and poor silvicultural practices, among others. Genetic diversity (intra species diversity among populations) provides fundamental basis for natural selection and evolution of forest tree species. It buffers the ecosystem against environmental changes or in other words imparts adaptability to a growing population especially under predicted climate change scenario. Even though, Western Ghats is a hub of floral biodiversity, the effect of depletion of natural resources on genetic diversity has been explored in a limited number of tree species. This article reports the population genetic analysis of two commercially important tree species teak (*Tectona grandis* L.f.) and sandal (*Santalum album* L.), an endemic tree species (*Humboltia brunonis.* Wall) and two key stone tree species (*Ficus hispida* Vahl. and *F.exasperata* L.f.) of the Western Ghats using various molecular marker techniques, *viz.* isozymes, random amplified polymorphic DNAs (RAPDs), amplified fragment length polymorphisms (AFLPs), inter simple sequence repeats (ISSRs) and simple sequence repeats (SSRs), that have been evolved over the last three decades.


Santalum album L.

The most common metrics of genetic diversity such as allelic richness (average number of alleles per locus) and allele diversity, percentage of polymorphic loci (the percentage of loci that are polymorphic), genetic diversity (h) within and between populations, observed (Ho) and expected heterozygosity (He) (the average proportion of loci that carry two different alleles at a single locus within an individual), genetic differentiation, gene flow, fine-scale genetic structure etc. have been estimated using various population genetics softwares such as POPGEN, STUCTURE, PHYLIP, FSTAT, SPAGeDi, GenoDiv., AFLP-SURV, among others.

Indian sandalwood is the most appreciated tropical hardwood species in the world, for its fragrant heartwood and oil. The global supply of Indian sandalwood has reached critical levels due to illicit felling and overharvest, with the species being recognised as vulnerable (IUCN, 2009). Genetic diversity within and between five Indian sandal provenances, namely Marayoor (Kerala), Bangalore, Mandagadde and Thangli

(Karnataka) and Javadis (Tamil Nadu) were investigated using five metabolic enzymes *viz*., peroxidase, shikimate dehydrogenase, glucophosphate isomerase, malate dehydrogenase, esterase as well as randomly amplified polymorphic DNA (RAPDs) markers. The study revealed the genetic diversity status of the sandal provenances in India with the highest genetic diversity in the Marayoor provenance of Kerala. Least amount of gene flow observed (0.069) resulted in the genetic differentiation of provenances with 78.3% among the provenances. The genetic relatedness of the five provenances was revealed by the UPGMA dendrogram, which comprised of mainly two clusters. Bangalore and Thangli were the most genetically similar and Marayoor and Mandagadde were the most diverse provenances. The low degree of genetic variability within sandal provenances might be due to fragmentation of a previously large population resulting in loss of genetic variation, least amount of gene flow among provenances and differentiation of populations due to genetic drift (Suma and Balasundaran, 2003). Accordingly, genetic restoration programs have been undertaken through the establishment superior genotypes from different locations in Marayoor and thereby enhancing the available genetic resources in the degraded Marayoor reserve (Balasundaran, 2010)


Tectona grandis L.f.

Teak is one of the most durable timbers in the world that is used for all conceivable purposes. Its widespread use has constrained the distribution of species to small and isolated populations. The genetic structure within and between nine teak growing natural forests of the Western Ghats namely Konni reserve forests, Peechi-Vazhani Wildlife sanctuary, Parambikulam Wildlife sanctuary, Nilambur reserve forests, Wayanad Wildlife sanctuary all belonging to Kerala state, Indira Gandhi Wildlife sanctuary from Tamil Nadu, Shimoga reserve forests, and Barchi and Dandeli reserve forests belonging to Haliyal Forest Division (Dandeli Wildlife sanctuary) from Karnataka was investigated using amplified fragment length polymorphism (AFLP) markers. The Southern Western Ghats populations from Kerala showed higher within population gene diversity. The relative magnitude of genetic differentiation (GST) was 0.24 indicating that 24% of total gene diversity was among the natural populations while the remaining 76% of total variation occurred within the populations. Positive correlation between genetic and geographical distances was also observed. PCoA, UPGMA and STRUCTURE analyses revealed the tendency of the individual trees within a population to align together indicating specific identity of each population. A few of the best quality teak provenances such as Nilambur, and Dandeli known for their unique characters have lost genetic diversity quicker than other provenances of the Western Ghats. These facts invite attention towards the necessity of adopting more efficient and scientific methods for *in situ* and *ex situ* conservation of the remaining natural teak resources in the Western Ghats. However, there are natural teak forests showing large genetic diversity such as reserve forests of Konni, Wayanad, Parambikulam and Peechi-Vazhani as revealed in the present study. This necessitates the protection of not only these patches of natural teak forests but also the entire teak forests of the Western Ghats so as to conserve their genetic diversity for sustainable use for the future (Sreekanth et al., 2012).

Humboldtia brunonis is a dominant self-incompatible ant-plant or myrmecophyte, growing as an understorey tree in high-density patches. It is endemic to the biodiversity hotspot of the southern Western Ghats of India and, besides ants, harbours many endemic invertebrate taxa, such as bees that pollinate it as well as arboreal earthworms, within swollen hollow stem internodes called domatia. Using inter simple

sequence repeat (ISSR) markers for the study, three geographically separated populations were found to be multiclonal, characterized by high levels of clonal diversity. This myrmecophyte was found to combine sexual recruitment (66.7%) and clonal production (33.3%) as methods of reproduction. Moderate level of genetic diversity at the species level was observed with 52.63% polymorphism, and moderate values of Shannon's diversity index (0.1895) as well as of Nei's gene diversity (0.1186). In each population, observed genotypic diversity was significantly lower than expected, indicating significant genetic structure. Some neighbourhoods within each population showed spatial genetic structure even at small spatial scales of <5 m. A combination of clonality and short-distance pollen movement by small pollinating bees (*Braunsapis puangensis*) coupled with primary ballistic seed dispersal, and possible secondary seed dispersal by rodents, may contribute to spatial genaetic structure at such small scales. The clonality of *H. brunonis* may be a factor that contributes to its dominance in Western Ghat forests where it supports a rich diversity of invertebrate fauna (Dev et al., 2011).

Although *Ficus* is a keystone plant genus in the tropics providing resources to many frugivorous vertebrates, its population genetic structure, which is an important determinant of its long-term survival, has rarely been investigated. We examined the population genetic structure of two dioecious fig species (*Ficus hispida* and *Ficus exasperata*) in the Western Ghats using co-dominant nuclear microsatellite (SSR) markers.

Ficus exasperata Vahl.

We found high levels of genetic diversity in both species. The regression slopes between genetic relationship coefficients (fij) and spatial distances were significantly negative in both species indicating that, on average, individuals in close spatial proximity were more likely to be related than individuals further apart. Mean parent–offspring distance(s) calculated using these slopes was about 200m in both species. This should be contrasted with the very long pollen dispersal distances documented for monoecious *Ficus* species. Nevertheless, overall population genetic diversity remained large suggesting immigrant gene flow (Dev et al., 2012).

Forest tree species are generally long lived, extremely diverse and can adapt to a broad range of ecological conditions. The prevailing genetic diversity status of the analyzed tree species can guarantee survival and evolution to a certain extent under changing environmental conditions. Nevertheless, the outcomes of the present study can be effectively utilized for initiating conservation efforts so as to break the dispersal barrier on these precious forest tree genetic resources of Western Ghats. Further transcriptome analyses are also warranted to understand molecular architecture of adaptive traits so as to delineate natural populations. Identification of hotspots of genetic diversity based on adaptive traits would help in identifying the natural stands that could serve as seed sources for future plantations as well as aid in the selection of the best genetic material for improved tree growth, quality and adaptability.

References

Balasundaran M (2010) Improving sandal population in Marayoor sandal reserves through assisted natural regenearation. KFRI research report 349: 19p.ISSN 0970-8103.

Sreekanth PM, Balasundaran M, Nazeem PA, Suma TB (2012) Genetic diversity of nine natural *Tectona grandis* L. f. populations of the Western Ghats in Southern India. Conservation Genetics 13(5):1409-1412

Dev SA, Finn Kjellberg, Martine Hossaert-McKey, Renee M Borges (2011) Fine-scale population genetic structure of two Indian keystone species, *Ficus hispida* and *F. exasperata* (Moraceae). Biotropica 43 (3): 309-316

Dev SA, Megha Shenoy, Renee M Borges (2010) Genetic and clonal diversity of an endemic ant-plant *Humboldtia brunonis*. Journal of Biosciences 35 (4): 267-279

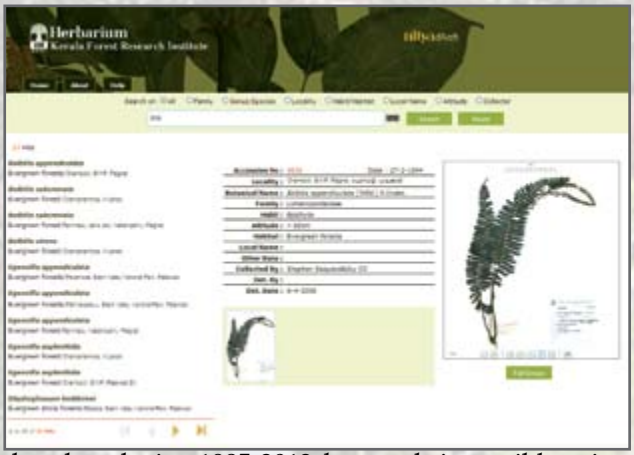
Suma TB, Balasundaran M (2003) Isozyme variation in five sandal provenances of India. Australian Journal of Botany 51(3): 243-249.

Evergreen (71) 9-10, 2013
ISSN : 0254-6426

Electronic Gateway to the Herbarium of KFRI

VB Sreekumar[1] and KH Hussain[2]
[1] Department of Botany, Kerala Forest Research Institute, Peechi, Thrissur-680653
[2]Library and Information Division, Kerala Forest Research Institute, Peechi, Thrissur-680653
Corresponding author : sreekumar@kfri.res.in

The KFRI herbarium was established in 1982 as an outcome of a research project by Sasidharan N and Nambiar VPK with 6000 specimens. It is recognized by the International Association of Plant Taxonomists (IAPT), and is known by the acronym KFRI by Index Herbarium (Taxon 37: 503. 1988). Now the herbarium holds over 10306 specimens representing more than 2040 species from 203 families and is one of the major reference herbarium of forest plants. It holds wide collection of flowering plants of Kerala, especially medicinal plants and a pan Indian collection of rattans, palms and bamboos of India including Andaman and Nicobar Islands. The species in the herbaria are indexed in alphabetical order with collection numbers under respective plant families and Bentham and Hooker's system of classification (1867-1883) has been followed for the systematic arrangements. The predominant plant families in the collection are Poaceae (171 spp.), Orchidaceae (151 spp.), Arecaceae (109 spp.), Fabaceae (81 spp.), Euphorbiaceae (96 spp.) and Rubiaceae (90 spp.). The herbarium is also represented with more than 90 species of pteridophytes and several lichens. Various research projects on regional floristic and ecological studies, taxonomic revisions which were undertaken during 1985-2012 has made it possible to improve the quality of the herbarium and now it is an active collection in continuous growth. The herbarium holds several valuable collections made by Nambiar VPK, Sasidharan N, Nair NG, Renuka C, Muktesh Kumar MS, Nair KKN, Sreekumar VB, Stephen Sequiera, Jayakumar R, Remesh M, et al., from different phytogeographic hot spots of India. For the easy instant access of specimens from any where in the world, we have digitized KFRI herbarium through a 3 year project "Computerization of KFRI Herbarium- Phase II" by Renuka C, Hussain KH and Sreekumar VB as investigators in 2009. The goal was to digitize all specimens and enable them to be made available to botanists and other researchers free of charge through a single portal. For this, all the sheets were imaged using Canon Powershot G9 camera and information content in the sheets was prepared as a database. The high resolution images provide easy understanding of micro-morphological features to identify the specimens. Each entry has all the information presented on the herbarium specimen label including Accession no, date of collection, locality, botanical name with author citation, family, habit, altitude, habitat, local name, field data, collectors name, determinavit details. The website is developed by Beehive Digital Concepts using standard open-source software Apache, MySql and PHP. Plant taxonomic data are stored in the database that allows rapid indexed searches. High quality digital images are stored as separate files for greater efficiency in magnifying and are displayed using advanced graphics. The website provides basic and



advanced search capabilities. Default search is conducted in all fields of the herbarium database, while advanced search allows searches in specific fields like genus, species, local names, etc. Queries can be built on multiple keys also such as "riverside, yellow flower". The interface is handling Unicode Malayalam for search using vernacular names of plants and location. Thus the "digital herbarium" representing forest flora will be highly useful to Forest Departments, Kerala State Biodiversity Board, Universities, Research Institutions, students and teachers especially for identifying specimens, understanding local names, distribution and phenological details etc. KFRI herbarium data can be accessed through the data portal at http://kfriherbarium.org/

Kerala Forest Seed Centre

The Kerala Forest Seed Centre (KFSC) was established in September 2003 jointly by the Kerala Forest Research Institute (KFRI) and the Kerala Forest Department (KFD) under the World Bank assisted Kerala Forestry project. It is located in the KFRI main campus, Peechi.

The main objective of the centre is to collect seeds of superior trees/stands, process, grade, store and supply to KFD, other government departments, non-governmental agencies, farmers and others interested in seeds of forest tree species for propagation. In addition to the supply of quality seeds of forestry species, facilities will be also used to undertake research in seed science and technology in tropical forestry species and to provide training for forestry professionals, researchers, students and others interested in seed related aspects.

The KFSC is headed by a senior scientist of KFRI having professional training and experience in Silviculture, Range Officer and Forester from KFD to facilitate the programmes and activities of the KFSC.

Facilities available in KFSC

KFSC has facilities for processing, grading and storage of seeds at low temperature, seed testing for insect /pest infestation and certification for seed weight, purity and viability.

Species for which seeds are available

Seeds of teak (*Tectona grandis*), rose wood (*Dalbergia sissoides* and *Dalbergia latifolia*), *Acacia* species, *Terminalia* species, *Caesalpinia sappan*, *Cassia fistula*, *Swietenia macrophylla*, *Aegle marmelos*, bamboo, rattan and several other tropical trees species of Kerala are available for sale. The list of tree seeds can be provided on request.

How to obtain seeds

Seeds in ready stock can be purchased from KFSC on all working days between 11 am and 3 pm. Request for purchase of seeds may be sent to the Scientist-in-Charge, KFSC or email to seedcentrekfri@gmail.com. A quotation will be provided to the purchaser, indicating the cost, tax and handling charges. On remittance of full payment by cash or bank draft (payable to the Registrar, KFRI, Peechi), the seeds will be sent by parcel/post/courier.

For seeds of species which may not have available stock, orders will have to be placed well in advance, at least three months before the seeding time of the species.

Seed certification

The seeds supplied will be certified for source, purity, germination percentage and number seeds per kilogram

Further information can be obtained from,
Scientist-in-charge
Kerala Forest Seed Centre
Kerala Forest Research Institute
Peechi, 680653, Thrissur
Kerala, India.
Ph- 0487- 2690345, 2690346

Evergreen (71) 11, 2013
ISSN : 0254-6426

Digital Archive of Indian Forest Series at KFRI Library

N Sarojam and KH Hussain

Library and Information Division, Kerala Forest Research Institute, Peechi,Thrissur-680653
Corresponding author : sarojam@kfri.org

Forestry is a multidisciplinary area of study which draws principles and practices from other pure and applied fields. In the digital age, research is mainly based on what is covered by information systems and what is available with a mouse click. Materials not covered by major databases and the networks, due to poor circulation and documentation, fail to come to the notice of practicing foresters and researchers.

Valuable observations made by the early forest officers during their tours in the forests form the foundation of forestry research in India. Initial forestry research was confined mainly to Botany, Wood Anatomy and Utilization of Timber and Minor Forest Products. The results of valuable scientific works carried out from time to time by way of individual efforts in special branches were serially published as Indian Forest Records, Bulletins, Leaflets, etc. Work done in the field of forestry are scattered in different journals and most of the databases covers only those published in widely circulated journals and proceedings published by prestigious institutions.

There doesn't exist a single database dedicated to forestry alone. Even though high amount is spent every year to purchase/subscribe databases like CABI there is no guarantee to cover Indian forestry exhaustively. One example would be the great silviculturist R.S Troup who laid the foundations of systematic research in Indian Forestry and at the same time least referred by the researchers now only because of the unavailability in cyberspace. Even trainers, teachers and students in the field of forestry are unaware of Indian Forest series.

History of the Series

In 1875, Sir William Schlich started the Indian Forester as a journal on forestry, agriculture, shikar and travel. In 1878 by the starting of the Forest School in Dehra Dun marked the real beginning though in a small way of scientific forestry research. A series of publications in forestry under headings Indian Forest Records, Forest Bulletins, Forest Leaflets, etc. are monographic treatments of various subjects in forestry. The topics covered are mostly of practical importance based on field experience of foresters. Most of these publications have been published between 1900-1980 by well known authorities in forestry such as Beeson CFC, Bor NL, Champion HG, Chatterjee NC, Stebbing EP, Troup RS, Seth SK, Gardner JCM, Griffith AL, etc. Many of these authors had worked at the Forest Research Institute (FRI), Dehradun and in the Indian Forest Services. These monographic publications of FRI in different series namely, Forest Bulletins 1911-1984, Forest Bulletins New Series 1941-1975, Forest Records 1908-1935, and Indian Forest Records (New Series) 1931-1983 are grouped under different topics like Botany, Chemistry, Entomology, Forest Management, Forest Pathology, Silviculture, Statistics, Timber Mechanics, Minor Forest Products, utilization, Wood Anatomy and Wood Preservation.

Former KFRI Librarian, Shri K. Ravindran was very keen in collecting all these by travelling to FRI, Dehradun and old forest department offices in Kerala. KFRI Library started to develop its databases as early as 1986 and now they are fully digitized. It is now opened and made available in KFRI intranet for search and retrieval of full text to scientists and students.

KFRI Research Reports

KFRI Res. Rep. No. 419

Establishment of a Pilot Scale Clonal Plantation of Promising Plus Trees of Teak

Surendran T

A project was undertaken to raise a pilot scale clonal plantation of promising plus trees of teak (*Tectona grandis* L.F). To raise the plantation, selected plus trees were cloned using the technique standardized at Kerala Forest Research Institute, Peechi. The technique mainly involves production of juvenile shoots on branch cuttings of plus trees, in the mist chamber. The produced juvenile shoots were rooted in the mist chamber to obtain true to type rooted cuttings (ramets) of the plus trees. After rooting the cuttings were hardened in the hardening chamber, before being taken out for field planting. A few days hardening in the open nursery were also provided to ensure field survival of rooted ramets. An area of about 1.0 ha was selected at Veliyanthode in Nilambur Range of Nilambur Forest Division (North) and the pilot scale plantation was established using the rooted ramets of teak plus trees.

KFRI Res. Rep. No. 420

Strengthening and Computerisation of KFRI Herbarium

Yesodharan K, Nair KKN

Computerization of KFRI Herbarium was undertaken to digitize the information about the herbarium specimens in such a way that it is easily accessible with the help of internet and World Wide Web (www) throughout the world. Modern databases also include the actual herbarium specimens as digital images with all accompanying information available on the herbarium sheet label. The digital database of the herbarium specimens was developed by selecting 33 variable characters by using software package "DELTA". The digital photos were attached to the database after feeding the characters. Nearly 1891 species belonging to 96 families of dicots and monocots have been incorporated in the digital herbarium till now. These contain rare, endangered and endemic plant specimens including type specimens. Digital herbarium database has some edge over traditional one as the herbarium will not have any pathogenic attack, no bio-degradation problems, no space problem, minimum maintenance cost etc. In addition, this database can be used for information retrieval, generation of conventional key and interactive key, and to get full description, brief description and diagnostic features of plants, current status of the plants, socio-economic values, etc.

KFRI Res. Rep. No. 421

Improvement of Teak through Genetic Evaluation

Indira EP

Selection and evaluation of plus trees through progeny trials are crucial steps in genetic improvement programmes. Half sib or full sib progeny trials allow the use of additive gene effects and hence, new recombinants can be identified and thereby paving way for further improvement.

A progeny trial plot was established under the present study at Nilambur with 64 families (progenies of 64 plus trees) to evaluate the breeding value of these plus trees. The trial was monitored for growth up to the age of five years after field planting. The results of the present study revealed that there is no influence of geographical origin of the families on growth performance. With respect to girth at breast height, the best cluster of families comprised progenies of plus trees T4, 6 and 24 from Nilambur, 19,136 and 137 from Konni, 105 and 106 from Kannavam, 48 and 150 from Arienkavu, 50 and 104 from Wynad and 121 from Parambikulam. The phenotypic and genotypic coefficients of variation as well as family heritability were moderate for height and girth in general. The progeny trial can accomplish the purpose of a seed orchard after removing the poor trees and allowing a minimum of 10 m spacing between trees.

The present study conducted using microsatellite markers, to determine the genetic similarity between plus tree clones and to exclude close relatives in further improvement programmes, showed possibility of demarcation of various clones from each other even

with two microsatellite markers except in two clones where three markers were necessary. The study also showed good genetic variability between clones. The clustering of ten clones revealed that all the clones from Arienkavu belonged to one group. Clone T20 from Konni was closer to Arienkavu clones rather than Nilambur clones. Plus tree clones T1 and T10 from Nilambur formed one cluster while T3 from Nilambur stood separately.

KFRI Res. Rep. No. 422

Microbial Diversity in the Grassland Shola Forests of Wayanad and Munnar

Maria Florence EJ

Soil microbial diversity and fungi involved in litter decomposition was studied for a period of two years in the Shola forests of Munnar and Wayanad. The Sholas selected were Mannavan Shola, Pambadum Shola and Manthan Shola in Munnar Forest Division and Meppadi Shola and Brahmagiri Shola in Wayanad Forest Division. The density of fungal population varied between Sholas. The population of fungi was highest in Pambadum Shola and lowest in Manthan Shola. Both in Pambadum and Manthan Shola the bacterial population was higher at a soil depth of 0-10 cm. The actinomycete population was also high in Manthan Shola at 0-10 cm and 10-20 cm depth. In Manthan Shola, the fungal density of fully decomposed leaf was low. *Aspergillus, Penicillium, Trichoderma, Verticillium* and *Pestalotiopsis* were the common dominant genus identified from all Sholas. Among the actinomycetes, the genus *Streptomyces* dominated in all Sholas. Seventeen species of fungi are new records to Kerala.

KFRI Res. Rep. No. 423

Stock Assessment and Yield Regulation for Teak Plantations in Kerala

Jayaraman K, Shivaraju B

The total extent of teak plantations was 56,509.45 ha as of 2011. An assessment of site quality distribution of the area showed that only 3 per cent of the area belonged to site quality class I. Nearly 33 per cent of the area was of site quality class II and 56 per cent was of site quality class III. Around 8 per cent of the area fell under site quality class IV. The plantations reached a stable age class distribution after 100 years. The major output of the study is the information generated at the individual plantation level on number of trees/ha, basal areas/ha, mean diameter, mean height, site index, site quality, stocking status, growing stock and proportion of miscellaneous species. The information derived at the Divisional level include area, site quality distribution, stocking status, growing stock, productivity and proportion of miscellaneous species.

KFRI Res. Rep. No. 424

Evaluation of *Saraca asoca*, *Kaempferia rotunda* their Substitutes and Medicinal Preparation with Respect to Phytochemical and Biological Properties

Sasidharan N

Lagenandra ovata and *L. toxicaria* are found to be substituted for *Kaempferia rotunda*. The medicinal properties of these substitutes are not studied well. In the present study, we assessed the phytochemical and biological properties of *Saraca asoca* and its substitutes like *Kingiodendron pinnatum, Cynometra beddomei, C. travancorica, Humboldtia vahliana* and *H. brunonis* and *Kaempferia rotunda* and its substitutes like *Lagenandra ovata and L. toxicaria* and 'Asokarishtam' prepared with preferred species as well as substitutes. On estradiol induced keratinization, *K. pinnatum* was found as effective as *S. asoca* in reducing the cornification in rat uterus. Arishtams prepared with *S. asoca* and substitutes were analyzed for their therapeutic efficacy. Among the Arishtams prepared with substitutes, *K. pinnatum* was the most effective. The results of the phytochemical and biological studies suggest that *Lagenandra ovata* and *L. toxicaria* cannot be substituted for *Kaempferia rotunda*.

KFRI Res. Rep. No. 425

Protocol for Residual Nutrients in the Soil

Balagopalan M, Rugmini P

Prolonged application of fertilizers beyond requirement of crop and natural occurrence of high levels of plant nutrients in soils can lead to high residual soil fertility. Knowing the residual fertility level of soil is important to determine if fertilizers are necessary for economically optimum crop production. The present study was undertaken to find out the status of

nutrients in soil at different periods after application in teak plantations and to develop a protocol for evaluation of residual nutrients in the soil.

The study was carried out in the teak plantations established in the years 2002 and 2003 at Pariyaram and Vellikkulangara Forest Ranges in the Chalakkudy Forest Division with root trainer seedlings and stumps. In each range, 24 blocks, each of 75 m x 15 m were demarcated of which 12 blocks each were for root trainer seedlings and stumps. The experiment was laid out in a complete randomized block design with five fertilizer treatments. The fertilizer treatment was the one prescribed by KFRI *viz*., 30 g each of N, P, K, Ca and Mg per plant during the first year and double the dose during the second and third years. The different fertilizer treatments selected for the study were control (T0), full dose of fertilizers (T1), 75% of full dose of fertilizers (T2), 50% of full dose of fertilizers (T3) and 25% of full dose of fertilizers (T4).

The soil samples from the experimental sites were analysed for general characteristics and initial N, P, K, Ca and Mg status. The soils at Vellikkulangara range were medium acid in all layers and sandy loam in the surface and loam in deeper layers. The organic carbon and total N as well as available P, K, Ca and Mg contents were low. At Pariyaram range, the soils were medium acid in all layers and loamy sand in the surface and loam in deeper layers. The organic carbon and total N as well as available P, K, Ca and Mg contents were also low.

In both the locations, the effect due to treatment, period and the interaction between period and treatment turned out to be highly significant with regard to height in root trainer seedlings as well as stumps. The interaction between period and treatment was highly significant, indicating that the treatments differed in their height growth pattern across time. Pair wise comparison between treatments at each period showed that the nutrient treatment recommended by KFRI differed significantly from all the other treatments.

The total N, and available P, K, Ca and Mg contents at the time of application of fertilizers and during three months of application revealed that there was an increase in the nutrient status which gradually decreased and approached close to the initial levels after three months at Vellikulangara range. The same pattern was observed at Pariyaram range. However, the P levels remained same during the second and third months of application of fertilizers. The persistence of the fertilizers in the soils revealed that within three months time, most of them were either degraded, adsorbed or leached. The etiquette for residual nutrients as well as the effect of nutrients on growth revealed that the recommendation of 30 g each of N, P, K, Ca and Mg in the first year and double the dose in the second and third years and rather than applying the whole dosage in single application, it would be prudent to apply in two or three split doses. Though economically and administratively unwieldy, from the scientific angle, this practice is highly beneficial.

KFRI Res. Rep. No. 426

Timber Supply Situation in Kerala: Projection for the Year 2010-11

Krishnankutty CN, Mammen Chundamannil

This study was initiated to make an estimate of the timber supply situation in Kerala for the year 2010-11. The projected demand for timber during 2010-11 in Kerala is 22,28,000 m3 roundwood. The households sector accounted for 24 per cent and industries sector 45 per cent of the total demand. Export of wooden packing cases and other timbers to the neighbouring States, accounted for around 31 per cent. The actual export to foreign countries from Kerala was negligible. When the export demand for packing case timber is considered along with the industrial demand, around 74 per cent of the total demand was from the industries sector. Export of packing cases was of the order of 6,40,000 m^3 during 2010-11. Rubber wood alone contributed 5,29,000 m^3 in this export. Sawmills serving the household and institutions sectors processed 5,41,000 m^3; while packing case units, which are also sawmills, processed 6,40,000 m^3.

Analysis of the timber supply situation in Kerala, revealed an export surplus of 3,17,000 m^3 during 2010-11. Contribution of forests was only 1.6 per cent and timber import represented 16.5 per cent of the total timber supply of 22,28,000 m^3 roundwood in Kerala. Rubber estates in Kerala produced 46.6 per cent; home gardens and other estates, the remaining 35.3 per cent. Import from other States stood at 1,51,000 m^3, which included 83,000 m^3 of rubber wood. The actual import

of timber from abroad was 2,16,000 m^3 during 2010-11. Timber imported from abroad was in the form of large dimension logs which have been severely depleted in the growing stock of timber in Kerala. Import of timber into Kerala has been growing and the trend is expected to continue in the future.

The study reveals a comfortable situation in the matter of timber availability in Kerala, due to the large volume of rubberwood production which is used by the packing case, plywood and even furniture industries. Construction timber is again plentiful from international sources. The sawmills in Kerala now depend mainly on timber imported from abroad. They also obtain timber from home gardens. The matchwood units continue to obtain their raw material mostly from home gardens around their production units. Some plywood units depend exclusively on imported timber.

Although production of timber from forests is negligible, there is no dearth of timber for timber-based industries in Kerala. They obtain their supplies from abroad and States like Karnataka, Gujarat and Maharashtra, apart from the home gardens and estates in Kerala. With the abundance of timber in the Kerala timber market and the availability of modern machinery to process the timber, new units are bound to replace the outdated and inefficient ones. This is a natural and welcome process for the economy and consumers. There is no relevance for imposing a number limit for wood based units in the context of changes in the scale of operations and market reach of particular units and the modernisation of the wood based industry in general. However, conservation of forests must be ensured by all means including restricting the location of sawmills near forest areas. If the message in the 2001 Wood Balance Study in Kerala by KFRI was to conserve the remaining timber wealth in the forests of Kerala, the message in this study is to conserve the timber resources in the home gardens also, to enable self sufficiency in large dimension timber, in the event of decline in availability of imported old growth timber from abroad in the future.

KFRI Res. Rep. No. 427

Optimizing Management of Bamboo Stands Using Growth Simulation Models

Jayaraman K, Pandalai RC, Sujatha MP

Bamboo (*Bamusa bambos*) is emerging as an important multiple-use plant both in forests and agricultural lands. However, no clear-cut guidelines have been found developed on optimal harvest levels based on quantitative methods. An attempt made in this direction is reported here based on a State level study initiated in the forests of Kerala.

Twenty two sample plots of size ranging from 30 m x 30 m to 50 m x 50 m were laid in different bamboo growing regions in Kerala. Observations on number of clumps, number of culms on selected clumps and culm height were made in each plot over three years. The status of miscellaneous species was also recorded. Soil samples were collected from each plot yearly and analyzed to evaluate the soil properties. The stand level values for the different attributes were worked out using allometric relations established for different characters with clump diameter. The number of clumps ranged from 72 to 444/ha in the year of establishment of sample plots. The range for number of mature culms was to the order of 1065 to 4197 culms/ha. Height of the tallest culm varied from 10.5 to 22.6 m. The soil properties also showed much variation over the twenty two plots.

Maximum sustainable harvest was worked out using linear programming algorithm implemented on a transition matrix model that depicted the changes in culm numbers of different size classes over time. With the level of natural destruction found occurring on the shoots produced every year, sustainable harvest levels varied from 102 mature culms/ha annually to 832 mature culms/ha every ten years.

Two cutting cycles of intervals three and five years, were evaluated through linear programming which maximized the land expectation value. With an annual discount rate of 9 per cent and average price of Rs 60 for a mature culm, five year cutting cycle was found better than three year cutting cycle especially when the management is poor. The superiority of five year cutting cycle was found retained for values of fixed cost ranging from nil to as high as Rs 10,000/ha. The optimal cutting intensity thus worked out to 50 per cent of the total number of culms in the stand every five years. Every five years, around 464 mature culms can be harvested leaving 102 mature and 357 immature culms in the stand. At the current rates, the harvest value works out to Rs 27,832/ha every five years less costs of harvesting. This happens in the presence of natural destruction of the shoots amounting to 50 per cent every year. If we are able to reduce the extent

of this damage, the harvests could be increased correspondingly.

Study on the effect of soil properties on the growth of bamboo showed that increment in diameter of the clumps was not affected by many soil properties except for Aluminium and pH. However, the increment in height was found influenced by gravel and phosphorus content. Additionally, the effect of soil on the growth of culms and transformation from immature to mature stage of the culms was investigated. The production of new shoots is seen affected by soil reaction. The transformation from immature to mature shoots reflective of the growth of the stand does not seem to be influenced by soil variables. However, these results are temporary as the estimates are based on a limited number of observations and also the plots were under severe external disturbances. With measurements coming from repeated measurements or larger number of plots, the results may get changed.

KFRI Res. Rep. No. 428

Intensive Cultivation for Root Production and Technology for Harvesting Roots of Five Medicinal Trees of Dasamoola

Sasidharan N, Chacko KC

The demand for herbal medicines, particularly Ayurveda, the most prevalent herbal system in Kerala is increasing every year. The raw drugs for manufacturing Ayurvedic medicines are collected mostly from the wild. The continued exploitation of raw drugs from wild sources has resulted in their depletion. In order to meet the increasing demand, cultivation is inevitable. Traditional cultivation practices of tree species are not practical for extracting roots. The present study suggests a rapid root technology for Dasamoola which is very convenient for farmers. Among the various containers used in the study, PVC pipes of size 100 x 15 cm were found to be ideal. They have several advantages for root production. The container can be reused further. There is absolutely no loss of roots while extracting.

There is a notion that mature roots of older trees are superior and therefore preferred in the preparation of medicines. In order to assess the suitability of roots produced by rapid root production methods, comparative phytochemical analyses were carried out. The TLC profile obtained for phenolics, alkaloids and flavanoids show more or less similar pattern for the roots of young and mature *Brehetpanchamoola* trees. These findings indicate that roots of young trees are qualitatively as good as those from mature trees and can be used in the preparation of Ayurvedic medicines.

KFRI Res. Rep. No. 429

Preparation of a Detailed Approach Paper for Adaptation and Mitigation Measures to Deal with Climate Change in the Forestry Sector of Kerala State

Chandrashekara UM, Jose Kallarackal, Lakhwinder Singh

Climate change is generally recognized as one of the greatest challenges of this century. In the present paper, the climate change impact factors such as precipitation, atmospheric temperature seal level changes and emission of greenhouse gases (GHGs) are discussed in the context of Kerala State. The high resolution daily gridded dataset for a period of 100 years (1901-2000) provided by the Climate Research Unit Time Series (CRU TS- version 2.10) was used to analyse the long-term trend of rainfall and temperature in Kerala. The mean annual rainfall and seasonal rainfall over the State showed an insignificant declining trend. The number of wet days during the South-West monsoon increased significantly and decreased during pre-monsoon and winter seasons. However, throughout the State daily average, maximum and minimum temperatures increased irrespective of the season. The data available for a period of 68 years (1939-2007) showed that the sea level rose significantly at the rate of 1.49 mm/year. Among different land use systems, forests are particularly sensitive to climate change. In the present paper, some possible impacts of climate change on forest species composition and diversity in Kerala are discussed.

The forest cover in the State seems to be stabilised to around 17,382 km^2. However, information on the quality of existing forest cover and its current ability for buffering the impacts of climate change is lacking. In the context of increasing anthropogenic activities, without adopting suitable mitigation and adaptation strategies, forests cannot contribute to mitigate the ill effects of climate change. Among several actions that can be taken in the forestry sector to

promote mitigation include a) managing forests with high carbon uptake potential, b) expanding such forests through reforestation and afforestation, and c) reducing deforestation and reversing the loss of forest cover. Several of the forest conservation measures already taken up by the Kerala Government are actually compatible to and contributing to the mitigation of the effects of climate change and are therefore to be continued and organised to target specific regions. By strengthening or continuing with programmes like social forestry projects and protection and conservation of forests, including sacred groves, adverse effects of climate change can be mitigated. With the long experience in promotion of forest conservation, participatory forest management and forest governance, the Kerala Forest Department can greatly facilitate comprehensive programmes for climate change mitigation. In the forest sector of Kerala, adaptation to climate change is also crucial due to the fact that the climate change could cause irreversible damage to unique ecosystems such as Sholas, mangroves, *Myristica* swamps, etc. In the present paper, actions to maintain or enhance a) forest extent, b) biodiversity, c) forest health, d) productivity in forest ecosystems and e) forest soil and water, are identified as important adaptation strategies. A number of options are highlighted under each adaptation strategy.

KFRI Res. Rep. No. 430

Strengthening and Rehabilitating the Bioresources Nature Park in the KFRI Sub Centre Campus

Chandrashekara UM

The Kerala Forest Research Institute, at its Sub Centre at Nilambur has developed about 12 ha of land into a Bioresources Nature Park. The Bioresources Nature Park has conservation themes for the lower groups of plants such as algae, bryophytes and pteridophytes, plants found in specialized ecological niche such as xerophytes (cacti and succulents) and hydrophytes (aquatic plants), beneficial plants (eg. medicinal plants) and ornamental plants (eg. orchids), with special reference to endemic and rare, endangered and threatened (RET) species. In order to improve the facilities in the Bioresources Nature Park, the Institute has initiated a short–term project. The specific objectives of the project were to a) strengthen and rehabilitate the Bioresources Nature Park, and b) assemble more species in each theme area of the Park. In the Nature Park, irrigation facilities such as pipe line, sprinkler and mist outlets provided were inadequate even to manage the existing plants in the garden. Thus, as a part of the project, irrigation facility has been strengthened. During the project period, emphasis has also been given to collect plant propagules of ferns and angiosperms and assemble them in appropriate theme area in the Bioresources Nature Trail. Details of new species introduced and individuals of existing species that were replaced with healthy ones are given in the report.

KFRI Res. Rep. No. 431

Empowerment of Community Reserve Stakeholders for Livelihood Enhancement and Conservation of Natural Resources at Kadalundi and Vallikkunnu Panchayaths

Mohammed Kunhi KV

Kadalundi –Vallikkunnu region is an estuarine ecosystem with unique ecological significance because of its rich and diverse nature resources especially mangrove vegetation, birds, fisheries, etc. The area is well-known destination and habitat of migratory and wetland birds. The mangroves, the mudflats, and the rich food available for the avian fauna had turned this location into one of the prominent ecosystem for birds of the World. The community of Kadalundi was never inhospitable to the winged guests. However due to population pressure, growing tourism industry and the unplanned development activities, it is likely that there can be threat for the ecosystem and its resources of especially mangroves, birds, fisheries and agricultural resources of the Kadalundi region. To prevent such growing threats and to provide space for co-existence of the community, resources and the estuarine system, the area has been declared as the Kadalundi-Vallikkunnu community reserve. The project aims to empower the community reserve stakeholders for livelihood enhancement and conservation of natural resources.

KFRI Res. Rep.No. 432

Upgradation of Small Timber and Bamboo Resources

Dhamodaran TK

*Eucalyptus gran*dis and *E. tereticornis* wood being non-durable, needs treatment with preservative chemicals.

Vacuum-pressure impregnation (VPI) treatment being more suitable for commercial scale applications in bulk quantity, an economical treatment schedule (15 minutes initial vacuum of 85 kPa followed by a pressure of 1300 kPa for 15 minutes and a final vacuum of 85 kPa for 5 minutes, denoted by 15'115'15') was developed for treating partially dry *E. grandis* wood with boron chemicals. Bamboo is found pressure treatable. An effective schedule capable for commercial scale pressure treatment of bamboo for industrial use was developed. some natural dyes yield colors by direct dyeing and do not require any mordanting whereas some other dyes impart a different color after mordanting.

KFRI Res.Rep.No. 433

Potential of Using Coir Geo-textiles in Highly Degraded areas for Improving the Soil and the Productivity

Balagopalan M

Coir geo-textile currently enjoys a high demand across the world. The experiment was conducted in split plot design with two nutrient combinations *viz*., control (To) and high input management (TI) as the main plot treatments and three coir geo-textiles size levels *viz*., without coir geo-textiles (A); 1 cm x 1 cm mesh size coir geo-textile (B) and 2 cm x 2 cm mesh size coir geo-textile (C) as the subplot treatments. Among the two plots where coir geo-textiles were spread, erosion and loss of nutrients were lower in plots where coir geo-textiles of 1 cm x 1 cm mesh size were spread. There was considerable increase in the soil moisture and decrease in the soil temperature in all the months in plots with coir geo-textiles. Soil moisture and soil temperature were substantially lower in the plots where coir geo-textiles of l cm x l cm mesh size was spread.

KFRI Res. Rep. No. 434

Development and maintenance of the Medicinal Plants Garden in the Peechi Campus

Sasidharan N

Collection of medicinal plants is unsustainable, because little consideration is shown by people while collecting. Outside the forests, there is no *ex situ* conservation centre for the medicinal plants. The National Medicinal Plants Board (NMPB) also support *ex situ* conservation of medicinal plants. Among the R & D centers of the Kerala State Council for Science, Technology & Environment, Kerala Forest Research Institute, Peechi, Jawaharlal Nehru Tropical Botanical Garden and Research Institute, Palode, Thiruvananthapuram and Malabar Botanical Garden, Olavanna, Kozhikode maintain Medicinal plants Gardens. The Medicinal plants Garden at Peechi campus was established as early as in 1979. The Nilambur sub centre of the Institute also has Medicinal plants Garden with about 200 species. The main objectives of establishing the medicinal plants garden of KFRI are conservation, education and extension. The Medicinal plants garden of the Institute was a part a research project —Studies on the Medicinal Plants of Kerala Forests.

KFRI Res.Rep. No.435

Model Watershed - Maintenance Monitoring and Outreach

Sankar S, Thomas TP, Unni KK

Water is a vital natural resource which is indispensable for the existence of all living matter: plant, animal and man (Ullah et al., 1972). Since water is a vital resource, the necessity for its conservation needs emphasis. To control the water yield and to improve the water resources, the proper approach is sound watershed management. Watershed integrates all the hydrological phenomena pertaining to its boundaries and as such is a logical unit for planning optimal development of soil and water resources (Holton, 1969). The State of Kerala, although receives an annual rainfall of ca. 3000 mm is affected either by floods or droughts. Conventional methods of creating reservoirs, dams, inter-basin transfers have failed to achieve the desired results on the one hand and cost the exchequer dearly on the other. In this context cost effective localised methods to control the flow of water and also to enhance infiltration gather importance.

KFRI Res. Rep. No. 436

Species Recovery of Selected Endangered Rattan Species of the Western Ghats

Indira EP , Renuka C, Sreekumar VB

Two types of DNA markers, Random amplified polymorphic DNA (RAPD) and Inter- simple sequence repeat (ISSR), were employed to estimate the genetic diversity of 12 populations belonging to the four

Calamus species. The results through 20 RAPD and 9 ISSR marker analysis showed that the population of *C. dransfieldii* seen only in Dhoni Forest of Olavakkode Division has high gene diversity. The populations are moderately diverse and the genetic differentiation between them is around 20%. Within population gene diversities are low in *C. vattayila* populations, Nelliampathy, Sholayar and Kallar. Likewise, OPAW 20 another RAPD marker is capable of detecting male plants in *C. brandisii*. One thousand seedlings of *C. vattayila* and *C. travancoricus*, originated from nine populations from Kerala, were field planted in Malayattur Division. For enriching the existing populations to create genetically robust populations, populations having high gene diversity were identified.

KFRI Res. Rep. No. 437

Common Birds of Kerala

Jayson EA

Books available on the birds of Kerala are published by Dr. Salim Ali (Birds of Kerala) and the classical Malayalam book by K.K. Neelakantan (Keralathile Pakshikal). An addition to the Birds of Kerala was published by Sasikumar *et al.* (1993) including the newly discovered bird species from Kerala. Another book on the Waders of Kerala was published by Sasikumar *et. al.* (2005). An inventory on the birds of Kerala was published by Easa and Jayson (2004). This publication will be useful to the bird watchers, students, naturalists, conservationists and to the scientific community. Available data on the birds of Kerala was collected from literature and reprints. In addition to these, notes were added from the personal observation on birds in the field. Basic information on morphology and behaviour was adopted from published material.

KFRI Res. Rep. No. 438

A Field Guide to the Palms of India

Renuka C, Sreekumar VB

Palms are woody monocotyledons belonging to the family Palmae (Arecaceae). They are a natural group of plants with a characteristic appearance that enables most people to recognize them without great difficulty. The Kerala Forest Research Institute has been surveying and studying the palm resources of India since 1983. The long field experience and research has resulted the publication of a Field guide, which covers 105 palms under 22 genera with simple description, maps

and colour photographs representing the species from all over India including Andaman & Nicobar Islands. Relevant illustrations are provided for easy understanding of scientific terms in this guide. The classification of palms is followed by a generic key and under each genus, generic description and species level keys are also included. The species distribution maps are included for each species using GPS co-ordinates taken during the field surveys and for each geographical area separate map is provided. Almost all the species are provided by more than four photographs relevant to the identification point of view.

Academic and Extension Activities

Publications in Journals

Sajitha KL and Florence EJM (2013) Effects of *Streptomyces* sp. on growth of rubberwood sapstain fungus *Lasiodiplodia theobromae*. Journal of Tropical Forest Science 23(3): 393-399

Sreejith KA (2013) Human impact on Kuttanad wetland ecosystem -an overview. International Journal of Science, Environment and Technology, 2 (4), 679 – 690

Chandrasekhara Pillai PK, Pandalai RC, Dhamodaran TK and Sankaran KV (2013) Effect of silvicultural practices on fibre properties of *Eucalyptus* wood from short-rotation plantations. New Forests 44 (4): 521-532.

Pillai PKC, Pandalai RC, Dhamodaran TK and Sankaran KV (2013) Wood density and heartwood proportion in *Eucalyptus* trees from intensively-managed short-rotation plantations in Kerala, India. Journal of Tropical Forest Science 25 (2): 220–227.

Jose PA, and Pandurangan AG (2012) Reproductive biology of *Ochreinauclea missionis* (Wall. ex G. Don) Ridsd. An endemic and vulnerable tree from the Western Ghats, India. Ann. For. 20(2) : 161-167.

Sujanapal P, Salim PM, Anil Kumar N and Sasidharan N (2013). A new species of *Ceropegia* (Apocynaceae-Asclepiadoideae) from India with notes on rare and threatened *Ceropegia* in Nilgiris of Western Ghats. Journal of Botanical Research Institute of Texas 7(1): 341 – 345.

Sujanapal P, Robi AJ, Udayan PS and Dantus KJ (2013). *Syzygium sasidharanii* sp. nov. (Myrtaceae) – A new species with edible fruits from Agasthyamala Hills of Western Ghats, India. International Journal of Advanced Research 1(5): 44-48

Deepika N, Eganathan P, Sujanapal P and Ajay Parida (2013). Chemical composition of *Syzygium benthamianum* (Wt. ex Duthie) Gamble essential oil - An endemic and vulnerable tree species. Journal of Essential Oil Bearing Plants 16(2): 289-293

Vignesh R, Puhazhselvan P, Sangeethkumar M, Saranya J, Eganathan P and Sujanapal P (2013). GC-MS Analysis, antimicrobial, scavenging ability and cytotoxic activity of leaves of *Syzygium calophyllifolium* Walp. Journal of Biologically Active Products from Nature 3(2): 121-129

Pius OL, Sujanapal P, Varghese AO and Udayan PS (2013). Vegetation characteristics of southern secondary moist mixed deciduous forests of windward Anamalai's of Western Ghats, India. International Journal of Integrative Sciences, Innovation and Technology 2(3): 42-53

Papers/Chapters in Books/Proceedings/ Newsletters

Sreejith KA, Chandrashekara UM, Nirmesh TK and Sreekumar VB (2013) Population dynamics and regeneration status of *Hopea racophloea*, a red listed species in Nadukani forest area, Kerala Part of Nilgiri Biosphere. National Conference on Nilgiri Biosphere Reserve held at Udhagamandalam, Nilgiris on 28-30 August, 2013.

Chandrasekhara Pillai PK (2013) Need for conserving the dwindling population of *Terminalia travancorensis* Wt. & Arn., an endemic tree in the Western Ghats. Pp 251-255. In: Kishorekumar, K., Balakrishnan, P., Balakrishnan P. and Rajesh M.G. (Eds.) Proceedings of the UGC National Seminar on 'Western Ghats – Biogeography, Biodiversity & Conservation', 14-16 February, 2013, Department of Botany, NSS College, Manjeri.

Suganthasakthivel R and Ramachandran KK (2013) Population ecology of lion-tailed macaques in the Silent Valley environs of the Nilgiri Biosphere Reserve. In: Anand Parthasarathy (Ed.) Environment & Society: The India Challenge, A festschrift in honour of Prof. M.K.Prasad. India Tech Books & Media, Bangalore. pp. 174-184.

Jose PA, Sumod M. and Chandrasekhara Pillai PK (2013) Ecorestoration of *Hydnocarpus macrocarpa* and *Drypetes malabarica*, two endemic endangered trees of the Western Ghats. Evergreen, Newsletter of Kerala Forest Research Institute, Peechi, 69-70, April-2012-March 2013.

Sani Lookose (2013) Traditional use of teakwood in households of Kerala. Published in the proceedings of National Conference on 'Environment and Sustainable Development: Issues and Challenges' at G. Venkataswamy Naidu College, Kovilpatti,

Tamil Nadu. Feb. 22 & 23, 2013 pp.89-103

Suma Arun Dev, Muralidharan EM , Sujanapal P, and Balasundaran M (2013) DNA barcoding as a promising tool for the identification of sandalwood adulterants. In: Proceedings of the National Seminar on Tree Biotechnology 2013, Emerging opportunities in forestry and tree science, (Eds. Dasguptha M, Warrier RR and Yasodha R) IFGTB, Coimbatore, Tamil Nadu, India, 23-24 September 2013, pp 299-301.

Suma Arun Dev, Sreekumar VB and Mutesh Kumar (2013). Phylogenetic relationships among endemic bamboos and its related genera in Andaman-Nicobar islands. In: Proceedings of the National Seminar on Tree Biotechnology 2013, Emerging opportunities in forestry and tree science, (Eds. Dasguptha M, Warrier RR and Yasodha R) IFGTB, Coimbatore, Tamil Nadu, India, 23-24 September 2013, pp 16-163.

Seminars/Workshops/Training Attended

Dr. PK Chandrasekhara Pillai

National Seminar on 'Western Ghats – Biogeography, Biodiversity & Conservation', 14-16 February, 2013, NSS College, Manjeri.

International Workshop on "Statistics in Action" held at Yashwantrao Chavan Maharashtra Open University, Nashik during 7-10 March, 2013, organized by International Statistical Institute's Outreach Committee for South Asia jointly with Yashwantrao Chavan Maharashtra Open University, Nashik and B.Y.K (Sinnar) College of Commerce, Nashik supported by World Bank Trust Fund for Statistical Capacity Building.

Dr. KK Ramachandran

National Seminar on "Environment and Society: India Challege (ESTIC 2013)" held on World Environment Day, 5th June 2013 at The (Taj) Gateway, Marine Drive, Ernakulam. Dr K.K. Ramachandran presented a paper entitled "Population ecology of lion-tailed macaques in the Silent Valley environs of Nilgiri Biosphere Reserve".

Dr. KA Sreejith

National Conference on Nilgiri Biosphere Reserve held at Udhagamandalam, Nilgiris on 28-30 August, 2013.

Dr. R Jayaraj

National Workshop on Pesticide related issues at Rubber Research Institute of India, Rubber Board, Kottayam on 29-30 August 13

Smt. Sani Lookose

Seminar on ''Geographical Indicator Protection for Nilambur Teak'' organised by Forestry College, Thrissur, IPR Cell, Thrissur, Geographical Indications Registry, Chennai and Nilambur Municipality on 28 September 2013 at Nilambur.

Extension activities/ Guest Lectures/ Classes

Dr. PK Chandrasekhara Pillai

Training for Farmers on 'Cultivation and Management of Bamboos' supported by Horticulture Department, Namakkal, Tamil Nadu during 25-27 March, 2013.

Training on 'Forest Nursery Management and Planting Stock Production' for Kudumbasree members of Puthur Panchayat sponsored by Puthur Panchayat, Thrissur on April 17, 2013.

Training on 'Forest Nursery and Planting Stock Production' for Kudumbasree members of Nadathara Panchayat sponsored by Puthur Panchayat, Thrissur on April 02, 2013.

Class on 'Seed technology' for Forestry students (B.Sc. (Forestry) programme – Safo 3207) of – KAU, Vellanikkara, Thrissur on July 05, 2013.

Dr. PA Jose

Coordinated the sapling planting activity during World environment day celebrations held in the Campus. 14 RET species consisting of 30 plants were supplied from the Nursery for planting activity.

Supplied 10 RET species consisting of 20 plants to the conservation garden at Nirmala College, Moovattupuzha.

Academic attachment (M.Sc- Botany) during April 2013- from St. Mary's College, Sulthan Bathery, wayanad

Smt. Sani Lookose

Organised Summer Training Course for students during 20-30 April 2013 through prior registration in Teak museum, KFRI Subcentre, Nilambur.

Documentary fest in connection with the Teak Museum Day on 21st May 2013, on topics related to Forest,Wildlife & Nature conservation and various environmental issues is organized in Teak Museum at KFRI Subcentre for the public and other organized groups during 21– 26 May 2013.

Conducted classes for students and teacher trainees of various educational institutions

Meetings Attended

Dr. KA Sreejith

Review of Mangrove Conservation Plans of Vembanad and Kannur Regions, meeting conducted by Principal Secretary, Forest & Wildlife Department on 01.08.2013 and 19.08.2013

Dr. KK Ramachandran

KSCSTE Scientists' Interface Meeting during 5th September to 8th September 2013 at Hotel Samudra (KTDC), Kovalam, Thiruvananthapuram.

Dr. PA Jose

Presented first progress report of the project, Conservation through restoration of Wild nutmeg tree populations of Western Ghats of Kerala before Research committee of Kerala Forest Department held on May 2013 at Head Quarters of Kerala Forest Department, Thiruvananthapuram.

Membership in Committees

Dr. PK Chandrasekhara Pillai

Member of the Advisory Committee of four Master's Degree students of the Department of Forest Genetic Resources, College of Forestry, Sirsi, University of Agricultural Sciences, Dharwad Karnataka State.

External examiner – Viva-Voce examination for Master's Degree students of the Department of Forest Genetic Resources, College of Forestry, Sirsi, Karnataka State on 12.04.2013 at Sirsi campus.

Dr. R Jayaraj

External Examiner at Central University of Kerala, for MSc Animal Science students for Biochemistry, Molecular Biology and Neuroendocrinology and Viva-Voce examination for Master's Degree students

Smt. Sani Lookose

Member in the Ad hoc committee formed to initiate the measures for the Geographical indications registration process for Nilambur teakwood articles.

Academic Attachment and Ph.D. Programmes

Ph.D. thesis Submission

Mr. Jijeesh C.M.	"Litter dynamics and carbon sequestration potential of selected bamboo species of Kerala"	FRI-DU	Dr. K.K. Seetha lakshmi

Acadamic Attachment Programme (April -September 2013)

Name	Department and Faculty	Subject
1. Remya C. Lakshman 2. Nayana Kamal 3. Muhsina TS 4. Medha Ramachandran 5. Preeji John Malppan 6. Mesha Mohammed	Wildlife Biology Dr. K.K. Ramachandran	Industrial Training in GIS
1. Rithusree Sudhakaran, 2. Riya KL	Wildlife Biology Dr. E.A. Jayson	MSW

Dr. C CHANDRASEKHARAN MEMORIAL AWARD 2013

Dr. C Chandrasekharan Memorial Award-2013 is presented to Mr. P.A. Vinayan by Mr. P.N.Unnikrishnan IFS (Retired Chief Conservator of Forests, Kerala) on 25th Sept 2013. Mr. Vinayan is an independent researcher grown up in Mananthavady, Wayanad, Kerala. He is a self-made field biologist specialising on bird communities while working closely with birding communities in Kerala and outside. An expert on birds, butterflies and odonata, Vinayan has no formal training or higher degrees in biology. Being an organic and responsive nature lover he has inspired and spearheaded many nature conservation campaigns and grassroots level nature education programmes in the region. He has authored field guides, nature education materials, survey reports and research papers based on his field work. He along with his close associates in the region had formed a conservation activist's group called FERNS, now an active NGO base in Wayanad working for nature conservation. Vinayan had worked in association with groups such as Key Stone Foundation, Wildlife trust of India, Malabar Natural History Society, Kerala Birder etc. Previously, he has worked on vulture conservation and human-animal conflict mitigation in the region. He was a full-time member of the team of ornithologists commissioned for revisiting the trail of Dr. Salim Ali during the Travancore –Cochin ornithological survey and has travelled the length and breadth of Kerala recording the birdlife along with the team.

He is currently working as a field biologist with WWF India for a study on the human-wildlife conflict which involves among other things tracking radio collared elephants in Nilgiri Biosphere Reserve and monitoring the pattern of crop raids by wild animals in the region.

Contact address :
PA Vinayan, Biologist, WWF, Field Station, Wayanad, Chethalayam PO, Wayanad, Kerala - 673592
Phone: +91 9497402761,
Email: pa.vinayan@gmail.com

Retirements

Dr. P Rugmini

Dr. Rugmini superannuated as Scientist F and Coordinator of the FMIS Programme Division, on 30th April, 2013 after 35 years of service. She has specialization in Biometrics, Growth modelling, Statistical analysis, Statistical Ecology and Experimental Design. Before joining KFRI in 17th Nov 1978, Dr Rugmini had served as a Lecturer in Statistics at Fatima College, Madurai. Her initial works were related to standardizing statistical techniques in forestry research, development of expert system for designing experiments in forestry, analysis of data from long term trials etc. Later, she was involved in research projects dealing with forest growth models besides conducting studies on the species specific growth models and preperation of volume tables for the plantation species such as *Acacia auriculiformis* and *A. mangium* in the social forestry plantations. Dr. Rugmini had also associated with works related to productivity and growth studies of the bamboo species, carbon storage potential of different age teak plantations in Kerala and soil organic carbon pools and its dynamics in the managed teak plantations of Kerala. She has 19 research reports and 60 research papers to her credit. We wish her a happy retirement life.

Dr. KK Seethalakshmi

Dr. Seethalakshmi superannuated as Scientist F and Coordinator of the Sustainable Forest Management Programme Division from KFRI on 31st May 2013 after 34 years of service. Dr. Seethalakshmi has completed her post-graduation in Botany from University of Calicut in 1975 with gold medal and her doctorate from Centre of Advanced Studies in Botany, University of Madras. She joined as a Scientist in Kerala Forest Research Institute during 1979 and since then involved in various multidisciplinary research projects related to Plant Physiology. Dr. Seethalakshmi did her Post Doctoral work in Hormone biochemistry with Dr. Peter Hedden at University of Bath and University of Bristol, U.K during 1995-96. Several R& D projects sponsored by various national and international agencies were carried out under her leadership. Currently she is Chief Consultant, Bamboo Technical Support Group, National Bamboo Mission, Ministry of Agriculture and Cooperation, Govt of India.

She has about 130 publications to her credit including books, research reports, scientific papers, handbooks, information bulletins and scientific articles. The book on "Bamboos of India: A compendium" is one of the comprehensive references available on Indian bamboos today. She has produced two doctorates and still guiding 6 students. she is also capable of transfer of scientific technologies for the benefit of public. Her efforts for capacity building through training in the areas of nursery and plantation techniques, product development and machineries for processing of bamboo has laid the foundation for an integrated development of bamboo sector in Kerala which is expected to generate employment for the rural poor, especially for women. She has also provided leadership for similar work in Southern and North-eastern India through collaborative projects. She has been recognized for her outstanding contribution for development of women through application of science and technology and received the national award from Department of Science and Technology, Government of India in 2004. She has visited Malaysia, Bhutan, Singapore, China and Myanmar for various professional meetings. We wish her a happy retirement life.

Humboldtia unijuga Bedd

A rare and endangered tree endemic to Agasthyamalai phytogeographical region of the Western Ghats. A lower stratum tree in mid elevation evergreen forests. Cauliflory is a common feature of this tree.

Family	: Fabaceae subfamily caesalpinioideae
Conservation status	: Endangered
Habit & Habitat	: Tree, Evergreen forests
Distribution	: Southern Western Ghats
Location of the photo	: Agasthyamala region in Thiruvananthapuram district of Kerala.
KFRI herbarium	: Accession No : 6432, dated : 20-12-1985

Contributor :
Dr. P Sujanapal
KFRI

Oriental Darter - *Anhinga melanogaster*

How to conserve ??

Habitat loss is one of the major threats faced by Oriental Darter. Maintain wetlands and nesting trees along the water fronts of your neighborhood

Oriental Darter *Anhinga melanogaster* is a water bird which mainly feeds on fish. It is commonly known as Snake bird because of its behavior of swimming in water with its long and slender neck above water which gives an appearance like a snake swimming in water.

Habitat:	Wetlands, mangroves, reservoirs and rivers.
Habit:	Feeds on fish, seen along with other water birds including Cormorants
Breeding :	From June to August. Nests on trees along with other water birds including Indian Cormorant, Little Cormorants and Night Herons. Clutch size varies from 3 to 5. Both sexes incubate the eggs.
Status:	Near Threatened (IUCN Red list)
Threats :	Habitat destruction and loss of nesting locations

Contributors :
Gnanakumar, Riju P Nair,
Sreedev Puthur, Sandeep Das
KFRI

Glimpses on trail...

Only few are lucky to witness the beauty of wild, here we get a chance to perceive through their viewfinders

Crested serpent eagle - *Spilornis cheela*
Nelliyampathy
Nikon D5100, Tamron 70-300mm
P Sreedev, sreedev59@gmail.com

Sonerila rotundifolia Bedd
Endemic to Southern Western Ghats
Silent Valley National Park
Cannon G9
PS Hareesh, hareeshhariz@gmail.com

Great Indian Hornbill- *Buceros bicornis*
Nelliyampathy
Nikon D 7000, Tamron 70-300mm
Riju P, rijupnair2009@gmail.com

Bos gaurus (Indian Gaur)
Parambikulam Tiger Reserve
Nikon D80, Lens: Sigma 170-500
Gnanakumar, kumargm33@gmail.com

Elephas maximus
Asian or Asiatic elephants
Vazhachal
Nikon D7000
Sandeep Das
sandeep.koodu@gmail.com